

Pattern and Technology: Why the *Chaîne Opératoire* Matters

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It is a pleasure to have the opportunity to contribute to a volume in honor of Ofer Bar-Yosef. I was first came across Ofer when, as a child, I read a synthetic article he wrote for the magazine *Qadmoniot* about the Natufian Period (Bar-Yosef 1974). I never imagined that I would spend much of my life studying the remote periods of time described in these articles or that I would have the opportunity to work with the author. In looking at Ofer's body of research three major themes emerge. The first is the importance of truly interdisciplinary research, epitomized by the collaborative field research developed at Kebara Cave. The second is the importance of major revolutions in prehistory. The third is the theme I want to contribute to here, the significance of culture for a real understanding of the archaeological record.

The idea I want to develop is that what I will refer to as *pattern* underlies many aspects of human cognition and human culture, including language, music, and technology. Pattern is defined as activity that requires a simultaneous grasp of sequence and structure. The route I will take is circuitous, beginning with anecdotes about modern technology and ritual before developing the argument that pattern is a critical aspect of the concept of the *chaîne opératoire*. In the final section I will enlarge the focus to show the role of pattern in language and music and to discuss some aspects of the cognitive science literature that

may be relevant to this concept. Throughout this is meant as an exploratory essay, an attempt to begin to grapple with an idea that warrants further development.

Not far from my house in Toronto crews are working to transform a major thoroughfare, St. Claire Avenue, into a road with a dedicated trolley lane. This involves ripping up and replacing the existing roadbed; the trolleys will travel on a raised concrete platform into which rails are embedded. I recently spent some time watching workers lay the concrete platform for the trolleys. Sequentially, I could identify a number of steps to this process: Cement came out of a cement mixer and was pushed down a chute to the roadbed. The mounds of cement were first flattened using a hoe and then smoothed using a large flat trowel. Bits of cement that overlapped the edge of the platform were trimmed using a triangular trowel and the surface of the cement was impressed with a decorative pattern using a large form. The cement mixer then moved forward and the process repeated itself. One could thus map out a sequence for the technical process of creating a raised cement roadbed. What struck me about the scene that I watched is that while there was a sequence underlying the workers activity what was actually taking place was constant action in which each 'step' of the process took place simultaneously, carried out by a different individual worker. Thus, while there was a sequence at work there was also a single unified action. Describing a sequence would provide only a partial description of the technical activity I observed.

The second anecdote comes from an element of Jewish daily morning prayers. After the age of thirteen this involves laying on *tefillin* as well as wearing a prayer shawl or *tallit*.

The *tefillin* are a fascinating bit of ritual behavior, which mixes very particular artifacts (leather straps and boxes containing handwritten scrolls), a sequence of bodily gestures, and language. There are two *tefillin*, one placed on the head and the second on the arm. I would like to focus on the latter. The *tefillin* is placed on the left arm so that the box containing a scroll points towards the heart. There is a type of slip knot in the leather strap that when drawn tight binds the top of the box to the arm and then the strap is wrapped around a ledge at the bottom of the box to secure the box tightly against the bicep. The *tiffilin* is then wrapped around the forearm using exactly seven loops. If my memory serves me there is a strict injunction against counting the loops. The leather strap is then bound around the hand and fingers in a series of loops that spell out one of the names of god. Finally, the remaining leather is looped around the hand and then secured by carefully tucking the last bit under the loop. Again, as with the case of road construction one can map out a sequence for laying on *tefillin*. But, once again, such sequence only gets at part of the picture. What fascinates me about the *tefillin* is the linkage between language and gesture, the theme that is so central to the writing of André Leroi-Gourhan (1964). Here language merges with the technical gesture (in this case ritual technique) to create an extremely powerful act. It is interesting that the use of language in regulating the technical act is proscribed (in counting the loops) while the name of god emerges from the technical act. For the *tefillin* to be grasped it must be understood as not simply a sequence but also as a whole, a grafting of the divine onto the body through a technical act.

It is a long way from road crews and *tefillin* to stone tools but my goal is to suggest that these very different spheres of activity are more similar than they first seem. The point of the two anecdotes is to illustrate that in many aspects of human technique, sequence alone is not an adequate basis for understanding. The concept of the *chaîne opératoire* builds precisely on recognition of this point. Unfortunately this aspect of the concept has been lost as it has traveled across the Atlantic.

In an important article Peter Bleed has stressed similarities between the American concept of a reduction sequence and Japanese and French approaches to analysis of production sequences (Bleed 2001). In the Japanese case, Bleed focuses on the concept of *giho*, citing studies on microcore techniques and subsequent studies by Fujiwara, Yanagizawa, Yanagida, and Kobayashi. When he turns to French archaeology, he focuses on the *chaîne opératoire*. It is true that the *chaîne opératoire* emphasizes the dynamic aspect of tool use and manufacture. However, the concept of *chaîne opératoire* also differs significantly from reduction sequence found in the North American literature (Andrefsky 2005). Trying to draw out the differences it is important to go beyond practice to the concepts that underlie analytic approaches. The critical component of the *chaîne opératoire* is that the dynamic process of manufacture is guided by a concept in the mind of the person carrying out the action. The knowledge (*connaissance*) of how to carry out the process is enacted through the skills (*savoir faire*) of the artisan (Pelegrin 1993). The *chaîne opératoire* is the acting out in time of knowledge and skill.

The breakthrough made by French lithic analysts has been the recognition that the

knowledge involved in stone tool manufacture is a three-dimensional concept of the mass. The term *method* refers to the rules guiding manufacturing process. These rules are not of a sequential nature (i.e., press button a then pull lever b) but rather they are rules about relationships that define the spatial organization of knapping. If these rules are not respected the artisan will not have control over the manufacturing process. The term *technique* is reserved for the means of transmitting energy in the knapping process, including the distinctions between hard and soft hammer and between direct and indirect percussion.

The application of the concept of *chaîne opératoire* to the study of stone tool manufacture has developed largely in the context of Middle Paleolithic archaeology, particularly focused on the definition of the Levallois method. In a series of influential papers a group of archaeologists including Eric Boëda, Jean-Michel Geneste, Lilliane Meignen and Jacques Pelegrin defined the Levallois method as a on the basis of five criteria (Fig. 1, Boëda and Pelegrin 1980, Boëda 1991, Geneste et al. 1990, Chazan 1997):

- (1) The volume of the piece to be worked is conceived as two surfaces that meet at a plane of intersection.
- (2) The two surfaces are hierarchically related, one being the platform face (usually the more convex of the two) and the other being the production face.
- (3) The production face is organized such that the morphology of products is predetermined. This predetermination is based on the management of lateral and distal convexities.

- (4) The fracture plane for the removal of predetermined flakes is subparallel to the plane of intersection between the two faces.
- (5) The striking platform is organized so as to allow the removal of the predetermined flakes from the production surface. This requires that the intersection of the striking platform surface and the flaking surface must be perpendicular to the flaking axis of the predetermined flakes. At the level of technique is stated that the Levallois method is used with direct percussion hard hammer technique.

It is interesting that François Bordes' typological definition of Levallois cores anticipated some of the traits identified in the technological definition. Notably Bordes did not define Levallois cores on the basis of a shape but rather in terms of the process of manufacture. Bordes wrote that to make a Levallois flake core one first prepares the core by removing flakes around the circumference. One then removes a series of flakes off the upper face of the core using the preceding removals as successive striking platforms. Finally, one "prepares a privileged striking platform at one of the ends of the core, either by small facets or by a single large removal, and one knocks off a Levallois flake, which possesses, more or less, the form of the core" Bordes 1967: 95). The difference between Bordes description of making a Levallois core and the contemporary definition of the Levallois method is precisely that Bordes recognizes only the sequential aspect of production without connecting this sequence to an underlying concept.

The technological definition of the Levallois method has been remarkably

productive, particularly in allowing for the definition of variability within the Levallois method and for the elucidation of other methods used by Middle Paleolithic knappers (Boëda 1991). For example, the discoid method is defined as differing from the Levallois method in that the fracture plane for the removal of predetermined flakes is at an acute or secant angle to the plane of intersection and the two surfaces are not hierarchically related. Within Levallois method an important distinction is made between linear methods in which one predetermined flake is removed from a production surface and recurrent methods, which allow for the removal of a series of predetermined flakes from each surface.

In my own research I have looked at the production of the twisted bladelets known as *Lamelles Dufour*, which are characteristic of the Aurignacian phase of the Upper Paleolithic (Chazan 1991 see also articles in Le Brun-Ricalens 2005). In the analysis of the assemblage from the assemblage from La Ferrassie in Southwestern France, I identified a method underlying bladelet production that could be adjusted based on the thickness of the flake used as a core. One interesting result of this study is to show that several of the tool types characteristic of the Aurignacian are actually the cores used to make *Lamelles Dufour*. In developing a means of representing the method used in making *Lamelles Dufour* I did present a sequence of steps (Figure 2). This type of sequential representation was possible in part due to the very rigid nature of the method. However, even in this case the sequence is not a sequence of motions but rather the steps through which a set of criteria were put in place by the knapper. As with the case of the

Levallois method, respecting these rules is essential for producing the desired end product.

In his analysis of the use of sequence models in archaeology Bleed makes a distinction between teleological models, in which he includes the *chaîne opératoire*, that are characterized as goal oriented sequences which move with a sense of inevitability from an initial state to a final product. In contrast, evolutionary models “describe results that are produced by selected interaction between conditions and variable” (Bleed 2001: 121). One can easily see why Bleed would see schemes such as the depiction of the Dufour bladelet method as teleological. However, such an interpretation of the *chaîne opératoire* fundamentally misses the centrality of the person who enacts the process. The *chaîne opératoire* is a process carried out by a skilled person and it is distinct from the kinds of sequences that characterize the operation of some machines and many aspects of animal behavior. The critical aspect of the *chaîne opératoire* is the method which is a concept held in the mind of the knapper. As the sequence or the *chaîne opératoire* develops it is constantly monitored by the knapper with reference to this concept.

Some of the nuance of the French term *chaîne opératoire* is lost in translation. The word *chaîne* is connected to the verb *enchainment* highlighting the significance of linkage between elements of a technological sequence. What ultimately is at stake is the temporality of technical actions, a highly complex issue that has been the subject of considerable philosophical analysis. I am suggesting that human technical actions are simultaneously sequential--that is that they move from point a to point b in time, that they

move from the present into the future—and based on a concept held by the person/people involved in the task. The temporality of the sequence is hard to pin down. In a certain sense the concept exists outside of time, while from another perspective past, present, and future are collapsed in the concept. In order to express this combination of sequence and concept I propose the use of the term pattern. A pattern implies something that can be read as a sequence but that also exists as a unitary phenomenon. A sequence of red, blue, and green beads that is repeated to form necklace can be read as a sequence of colors or as a unified design.

Two aspects of pattern need of further consideration. The first is to question whether there is an analogue to pattern in other aspects of human behavior. The second is to query whether pattern can be used to describe generative processes like technical action. A very close analogue to the concept of pattern as presented here can be found in Paul Ricouer's conception of narrative as a fundamental human activity (Ricouer 1984-1988). For Ricouer narrative is the human mechanism for reconciling the fundamentally irreconcilable dual nature of the human experience of time. On the one hand humans experience time as a sequence, but at the same time from a psychological perspective humans experience in every moment of time both the memory of the past and anticipation of the future. This fundamental insight can be traced back to St. Augustine and is essential to Ricouer's philosophy of narrative. It is perhaps telling that one of Ricouer's illustrations of the dual nature of the duality of human experience of time draws on a technical act, the playing of music by an orchestra. Actually, Ricouer focuses not on the players, a point I will return to below, but rather his attention is drawn to the experience

of the person hearing a piece of music. In listening to music we are clearly hearing a sequence of notes. But, our appreciation of music is based on our perception of each note being effected by the notes that preceeded it and anticipation of what is to come.

Is it significant that Ricouer considers the person hearing music as opposed to the musician? Ricouer's main focus of attention is the use of narrative in the activity of writing history, clearly a generative act as opposed to the passivity of hearing music. My sense is that there is a unity between the generative acts and what we might consider to be the more passive acts of perception. This is particularly important when we search for vocabulary to discuss the temporality of human technical action. The verb 'to parse' is a particularly apt term to use in discussing the apprehension of pattern. In parsing a poem one reads through the sequence of words and sounds to grasp the underlying pattern. I am not, however, aware of the active analogue, what it is that the poet does in creating a sequence that also has structure. The only term that comes to mind is 'composing' but there is something quite awkward about talking about a Neanderthal composing a Levallois core!

The proposal made here is that pattern is an essential aspect of human technical behavior. This implies that archaeologists must take into consideration both sequence and underlying concepts. If correct, the broader implication is that we have the tools to trace the prehistory of patterns, and from all indications this aspect of human technical behavior must date back at least to the beginning of the Acheulian. In the remainder of the paper I would like to make some very preliminary attempts to link the concept of

pattern in technical action to other critical aspects of human cognition-- specifically a sense of self, language, and music—and discuss one perspective from neuroscience that might help situate the cognitive capacity for pattern.

The question of whether or not a concept of self is unique to the hominin lineage is the subject of debate but there is strong evidence that the human sense of self differs significantly from what is found in chimpanzees. Several authors have pointed out that a sense of self would be essential for transmitting complex technological knowledge through active tutelage (Povinelli 2000, Tomasello 1999). Active teaching requires that the teacher take the perspective of the other, that the teacher recognizes the learner as a ‘self’ like them. The nature of ‘self’ is also a central subject of Ricoeur’s philosophical writing and it is interesting to consider the ‘self’ in opposition to the first person, ‘I’ (Ricoeur 1992). A ‘self’ implies an entity that endures through time, that exists in past, present, and future. Thus the human sense of ‘self’ draws precisely on the kind of collapsing of time that is found in patterned technical action. The concept of self requires a balancing of sequence and structure.

The questions surrounding the origins of the unique human capacity for language and music are the subject of considerable debate. One can characterize two essential schools of thought. The first, largely developing out of the work of Noam Chomsky, sees language as a domain specific cognitive ability. The second approach looks at the similarities between language and other cognitive tasks, particularly the production and comprehension of music. Clearly language and music have a great deal in common

(Patel 2003). Both music and language emerge in sequence but have an underlying syntax that is essential for both comprehension and production. Both are also flexible, with the same underlying cognitive operations producing a very wide array of expressions in terms of varieties of languages and musical styles. I would emphasize a third common aspect of music and language, their ability to interface with technology. The connection between music and tools for making music dates back at least to the Neolithic as do '*techniques du corpes*' involved in producing dance in coordination with music. Technologies for language are in the literal sense more recent, emerging with development of writing systems. However, linguistic anthropologists and linguists stress the importance of gesture, like dancing a '*technique du corpes*', in many aspects of language production (McNeill 2005). Thus, there is good reason to link language, music, and technicity and search for a common underlying cognitive structure. This is not to imply that language, music, and technicity are unitary phenomenon. Clearly this is not the case as language is unique in its ability to encode referential meaning (see Janata 2004, Koelsch et al. 2004). But, is there a perspective that would allow us to view language, music, and technicity as developing out of a common underlying cognitive process? Could these three abilities be the specialization of the underlying ability to act on the basis of pattern?

There has recently been increasing attention in the neuroscience literature to the cognitive processes involved in music (see Peretz and Zatorre 2005 for a review, Hauser and McDermott 2003 for an evolutionary perspective). Patel proposes that "linguistic and musical syntax share certain syntactic processes (instantiated in overlapping frontal brain

areas) that apply over different domain-specific syntactic representations in posterior brain regions” (Patel 2003: 679). From an evolutionary perspective this model, which Patel labels the ‘shared syntactic integration resource hypothesis’ (SSIRH), would suggest that the capacity for music and language in the hominin lineage developed through increased specialization in domain-specific syntactic representations that drew on common syntactic processes for integration of temporal sequences. If the technicity involved in stone tool manufacture does involve pattern, as recognized by the *chaîne opératoire*, the implication is that the evolutionary history of this underlying syntactic capacity is accessible through archaeological analysis. The corollary would be that archaeological analysis would not be informative with regards to the emergence of domain specific syntactic representations outside of technique.

In introducing this paper I claimed that I would be addressing the importance of culture for interpreting the archaeological record yet I have not mentioned culture once in the subsequent discussion. The term culture has over time acquired a degree of vagueness that makes it difficult to use. My sense is that when Bar-Yosef argues for the importance of culture he is not referring to systems of meaning but rather to systems of knowledge. This is where I find the idea of a cognitive linkage between language, music, and technicity to be so intriguing, because it is this linkage that leads to the emergence of culture as an interlocking system rather than a list of disparate properties. In terms of Near Eastern prehistory we can say, for example, that the Natufian is more than simply a type list.

In concluding an article on the shared neural substrate of sequencing and music Janata and Grafton write that “because music spans such a broad range of sensorimotor complexity, it provides a potential path for bridging the gap between abstract experimental task and real-world behavior” Janata and Grafton 2003: 687). I would argue that technicity offers a similar bridge and that through the archaeological record also allows us to examine the integration of sequential actions, what I have labeled patterning, in the hominin lineage.

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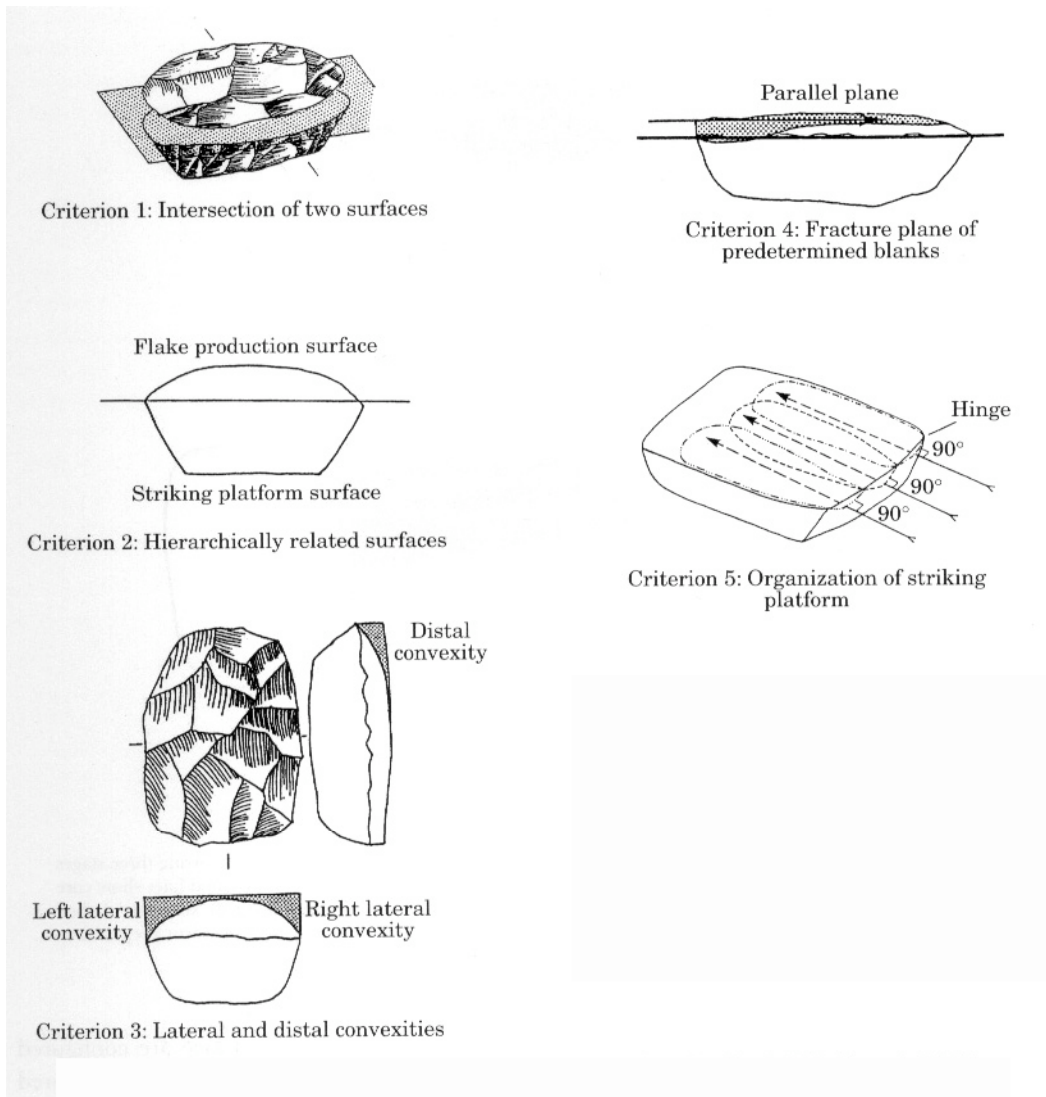


Figure 1: Five spatial criteria of the Levallois Method (after Chazan 1997 and Boëda 1991).

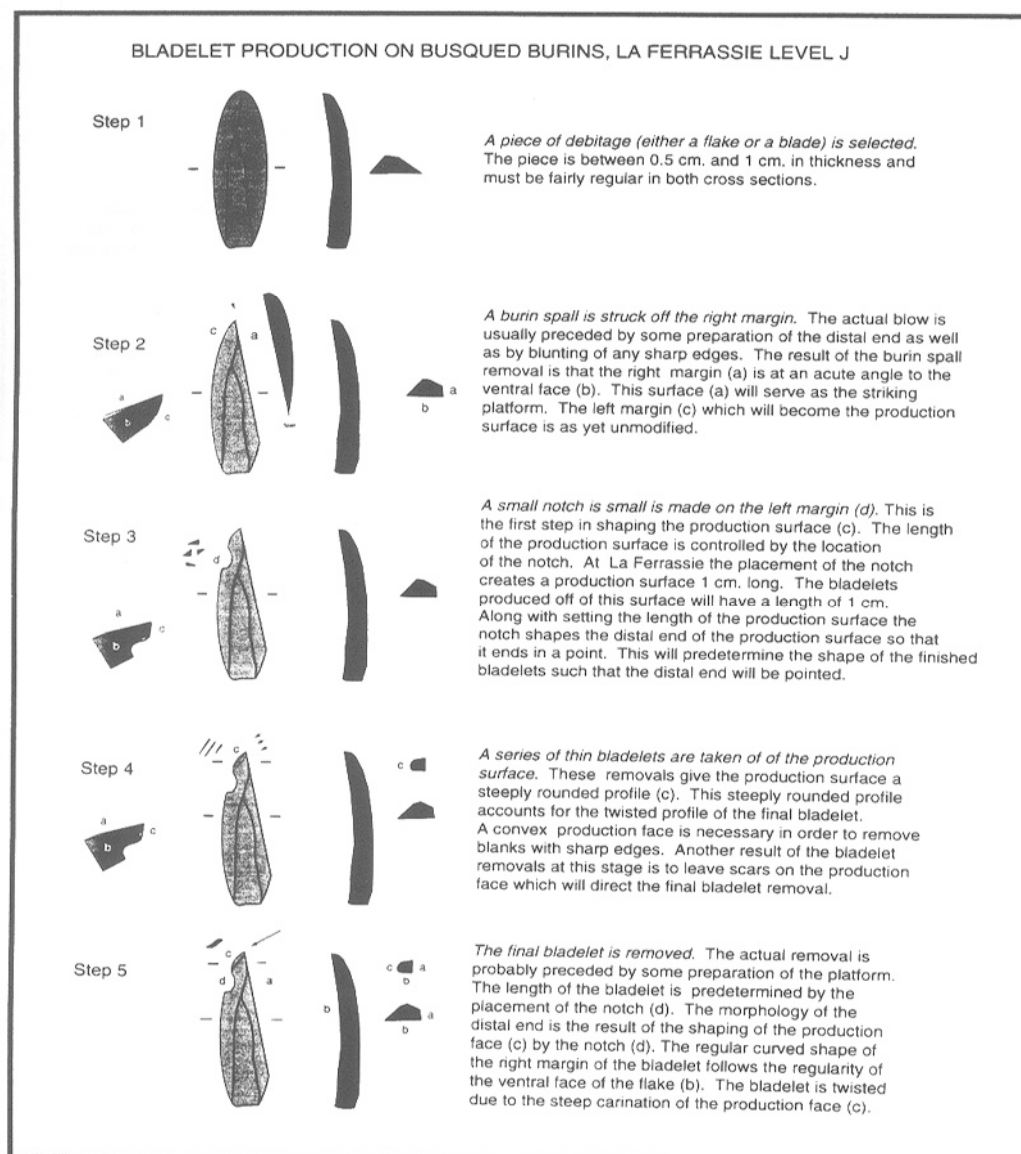


Figure 2: Dufour bladelet production on busqued burins a La Ferrassie (after Chazan 2001).